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IDENTIFICATION OF HABITATS OF SPECIAL IMPORTANCE TO RESIDENT KILLER WHALES (*ORCINUS ORCA*) OFF THE WEST COAST OF CANADA

Male (top) and female (bottom) Resident Killer Whales. Illustration by Uko Gorter.

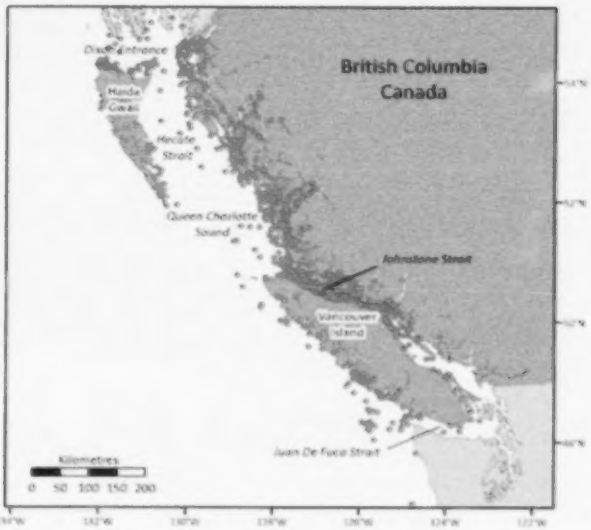


Figure 1. The British Columbia coast showing locations of sightings and encounters with Resident Killer Whales.

Context:

In 2001, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed Southern Resident Killer Whales (SRKWs) as Endangered and Northern Resident Killer Whales (NRKWs) as Threatened due to their small population sizes, low reproductive rates, recent unexplained declines in numbers, and the existence of a variety of anthropogenic threats (COSEWIC 2001). These listings became law under Schedule 1 of the Canadian Species at Risk Act (SARA) in 2003. The status of the SRKW and NRKW populations in Canada was reaffirmed by COSEWIC in 2008. A Recovery Strategy for Resident Killer Whales was published in 2011, with a goal to "ensure the long-term viability of Resident Killer Whale populations by achieving and maintaining demographic conditions that preserve their reproductive potential, genetic variation, and cultural continuity". The Recovery Strategy included partial identification of critical habitat and a schedule of studies to identify further areas that would be considered essential for the recovery of both SRKWs and NRKWs. The DFO Species at Risk Program has requested that DFO Science undertake an assessment of important habitats for SRKWs and NRKWs. Advice based on this assessment will be considered (by the relevant recovery teams and Species at Risk Program at DFO) in the identification of additional critical habitat for the action plans for these populations.

April 2017

Canada

SUMMARY

- Southern Resident (SRKW) and Northern Resident Killer Whales (NRKW) were listed as Endangered and Threatened, respectively, in 2003 under the Species at Risk Act (SARA) and a Recovery Strategy for these populations was completed in 2011. The goal of the Recovery Strategy is to "ensure the long-term viability of Resident Killer Whale populations by achieving and maintaining demographic conditions that preserve their reproductive potential, genetic variation, and cultural continuity".
- The Recovery Strategy included identification of an area of critical habitat for each of the populations. The main function of these habitats is for foraging and feeding on the whales' primary prey, Chinook Salmon, during summer and fall.
- The Recovery Strategy recognized that critical habitat for these populations was only partially identified, and provided a schedule of studies to identify additional critical habitat areas for Resident Killer Whales.
- Field studies conducted since the Recovery Strategy was completed have yielded new information sufficient to identify two habitats of special importance that may be necessary for the survival or recovery of SRKW and NRKW populations. These areas are located off southwestern Vancouver Island (an extension of existing SRKW critical habitat) and in western Dixon Entrance. 'Bounding boxes' are provided here that encompass these areas of special importance.
- Vessel surveys and passive acoustic monitoring (PAM) of whale vocalizations indicate that the habitat identified as being of special importance off southwestern Vancouver Island is used throughout the year by both SRKWs and NRKWs. Resident Killer Whales were detected acoustically in the area on one out of every three days, on average, during 2009–2011. The area is important for SRKWs during summer, when groups of whales make foraging excursions to the west of the currently designated critical habitat, and in winter when whales are mostly absent from the identified critical habitat, but frequently use this area. NRKWs also frequent this area during spring, when they are mostly absent from their designated critical habitat off northeastern Vancouver Island.
- Chinook Salmon, which occur seasonally in relatively high densities off southwestern Vancouver Island, is the predominant prey species consumed in the area during summer. Predation has also been documented on other salmonid species and sablefish.
- Vessel surveys and PAM demonstrate that waters of western Dixon Entrance, north of Graham Island in Haida Gwaii, provide a habitat of special importance for NRKWs throughout the year. As with southwestern Vancouver Island, this area is used most extensively by NRKWs when they are mostly absent from their legally identified critical habitat off northeastern Vancouver Island during late winter and spring. The area is also used by NRKW pods that rarely utilize the designated critical habitat at any time of the year.
- Chinook Salmon is the predominant prey of NRKWs in this habitat area during summer and probably other times of year. Western Dixon Entrance has long been known as a productive commercial troll fishing ground for Chinook Salmon as well as an important area for recreational Chinook fishing.
- The features and attributes of these important habitat areas include sufficient quantity and quality of critical prey species, particularly Chinook Salmon, water quality of a sufficient level so as not to result in loss of function, and an acoustic environment that does not interfere with communication or echolocation or cause disturbance and avoidance responses.

- Activities that are likely to result in the loss of functions of these important habitat areas include those that would result in reduced prey availability, acoustic disturbance, environmental contamination, and physical disturbance.
- Although the habitats of special importance identified in this report, together with previously legally identified critical habitat, are necessary for the survival or recovery of RKWs, it is unclear whether these habitats are sufficient to meet the goals of the Recovery Strategy related to Resident Killer Whales, particularly for NRKW. Further studies are needed to identify additional areas that may be critical at certain times of year or for particular groups within the populations of Resident Killer Whale.

BACKGROUND

Two populations of fish-eating Resident Killer Whales (*Orcinus orca*) inhabit waters off the Pacific coast of Canada. The two populations – Southern Resident and Northern Resident – are small (82 and 290 animals, respectively, 2014 census) and do not mix despite having overlapping ranges. Each is acoustically, genetically and culturally distinct. Both Southern Resident (SRKW) and Northern Resident (NRKW) populations forage selectively for Chinook Salmon (*Oncorhynchus tshawytscha*) and Chum Salmon (*O. keta*), and their movement patterns appear to be influenced by the availability of these preferred prey species (especially Chinook). The Northern Resident population is found regularly in nearshore waters off northeastern Vancouver Island during summer and fall, though their overall range is considerably greater, extending along the continental shelf from Washington State to Glacier Bay, Alaska. The smaller Southern Resident population is commonly found off southeastern Vancouver Island and adjacent inside waters of Washington state, from early summer to late fall.

In 2001, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed SRKWs as Endangered and Northern Residents as Threatened. Potentially important threats are reductions in the availability or quality of prey, environmental contamination, and both physical and acoustic disturbance caused by marine traffic and other industrial activities. These listings subsequently became law under Schedule 1 of the Canadian Species at Risk Act (SARA) in 2003. The Endangered and Threatened status of the SRKW and NRKW populations in Canada, respectively, was reaffirmed by COSEWIC in 2008. In the U.S., SRKWs were declared Depleted under the U.S. Marine Mammal Protection Act in 2003, Endangered by Washington State in 2004, and Endangered under the U.S. Endangered Species Act in 2006.

A Recovery Strategy for SRKW and NRKW was completed in 2011, with a goal to "ensure the long-term viability of Resident Killer Whale populations by achieving and maintaining demographic conditions that preserve their reproductive potential, genetic variation, and cultural continuity". The Recovery Strategy included identification of two areas of critical habitat, one for each of the two RKW populations. Both of these areas corresponded to the well-known "core areas" for the populations, where whales congregate, particularly in summer and fall, to intercept migrating Chinook and Chum salmon. For NRKWs, waters off northeastern Vancouver Island were identified as critical habitat, and for SRKWs, a portion of Canadian waters off southern Vancouver Island were identified (Figure 2). SRKW critical habitat in Canadian waters is contiguous with critical habitat that has been identified in US waters for this population.

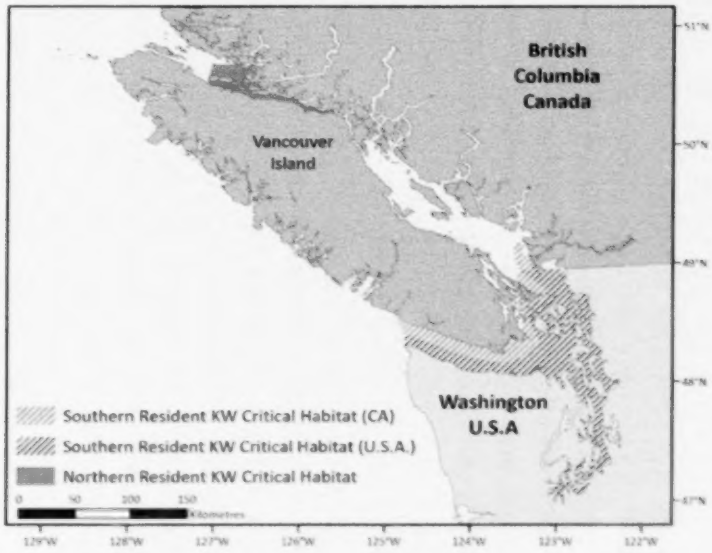


Figure 2. Designated critical habitats for Southern and Northern Resident Killer Whales. Critical habitat in Canadian waters is shown in red (designated in 2009), and in US waters in black (designated in 2006).

The Recovery Strategy did not fully identify critical habitat because insufficient information was available at that time. The two areas that were identified, and subsequently designated as critical habitats, are used extensively during summer and fall but are mostly unoccupied during winter and spring. Also, for the NRKW critical habitat, a portion of the population seldom or rarely uses the critical habitat area despite frequent use by other NRKW groups. A Schedule of Studies was developed in the Recovery Strategy, which called for "year-round comprehensive surveys to identify areas of occupancy" in order to "identify key feeding areas throughout the year to determine whether they should be proposed as additional critical habitat". The subsequent Action Plan for Resident Killer Whales includes several high priority actions related to the identification of additional critical habitat.

ASSESSMENT

Field studies were undertaken to identify additional areas of special importance to SRKWs and NRKWs that may be necessary to meet the survival or recovery goals described in the Recovery Strategy for Resident Killer Whales (Fisheries and Oceans Canada 2011). The same approaches that were used in the earlier identification of critical habitat in the Recovery Strategy were applied in these studies (Ford et. al. unpublished[1]). Information was collected on seasonal occurrence using vessel-based photo-identification surveys and passive acoustic monitoring. Tissue fragments and scales were collected at predation sites to identify prey and assess diet.

[1] Ford, J.K.B., Pilkington, J.F., Reira, A, Otsuki, M., Gisborne, B., Abernethy, R.A., Stredulinsky, E.H., Towers, J.R., and Ellis, G.M. (2016). Habitats of Special Importance to Resident Killer Whales (*Orcinus orca*) off the West Coast of Canada. DFO Can. Sci. Advis. Sec. Working paper from the February 23-26, 2016 "National Marine Mammal Peer Review Committee (NMMPRC): Part II", under Topic 1.

Two habitats of special importance were identified – southwestern Vancouver Island and western Dixon Entrance.

Southwestern Vancouver Island

This area extends westward from the mouth of Juan de Fuca Strait to include various banks on the continental shelf from the southwestern Vancouver Island coastline to the shelf break (200 m isobath). Boat-based encounters and, especially, detections of Resident Killer Whale vocalizations on acoustic recording instruments deployed at Swiftsure Bank indicate that these waters are important habitat for both SRKW and NRKW throughout most of the year. On average, Resident Killer Whales were detected on one out of every three days at Swiftsure Bank. During May to September, SRKWs were detected on 43% of monitored days. It is during these months that SRKWs typically spend the majority of their time in inside waters to the south and east of southern Vancouver Island, which includes areas previously designated as critical habitat in both Canada and the US. Previous studies have noted that SRKWs were present in these inside waters on an average of 80% of days during May–September but absent from the area on the remaining 20% of days. Given the frequent summer occurrence of Southern Resident pods off southwestern Vancouver Island documented here, it is evident that this area is a primary habitat used by these whales when outside of existing critical habitat during May–September. From November to May, two of the three pods that comprise the SRKW population, K and L pods, are generally absent from inside waters. During this period, they are known to range along the continental shelf as far south as northern California. Frequent detections of K and L pods at Swiftsure Bank during November to May and spring indicate that this area is also important winter and spring habitat for these groups.

Northern Resident Killer Whales also make frequent use of the waters off southwestern Vancouver Island. NRKWs were detected acoustically at Swiftsure Bank in all months of the year, but especially in March and April. In previously designated critical habitat for this population off northeastern Vancouver Island, NRKWs are typically found on most days during summer and fall but on < 10% of days during March and April. Pods belonging to G clan occur most often in the area, but all Northern Resident pods have been identified there.

The seasonal movement patterns of Resident Killer Whales are strongly influenced by the availability of Chinook Salmon, the whales' primary prey. Prey identified from scales and tissue fragments recovered from kills off southwestern Vancouver Island were predominantly Chinook Salmon (88% of 184 predation events), consistent with findings in other parts of the range of both Resident Killer Whale populations. Waters off southwestern Vancouver Island, particularly over the various banks including Swiftsure Bank and La Pérouse Bank, are known to be highly productive salmon habitats. These areas have long been targeted by both commercial and recreational troll fisheries for Chinook and Coho Salmon. Southwestern Vancouver Island is the entry point to the 'funnel' of Juan de Fuca Strait, through which many Chinook Salmon migrate en route to the Fraser River. This river system was the source of 80% of Chinook eaten by Resident Killer Whales off southwestern Vancouver Island and Juan de Fuca Strait (determined by genetic stock identification).

A 'bounding box' that encompasses the area of special importance to Resident Killer Whales off southwestern Vancouver Island is shown in Figure 3A. This eastern boundary is contiguous with the western extent of existing critical habitat at the entrance to Juan de Fuca Strait. The southern boundary is formed by the Canadian Exclusive Economic Zone border and extends to the 200 m isobath. The northern boundary is a line perpendicular to the coastline starting at Quisitis Point (48°59.73'N, 125°40.12'W) that also extends seaward to the 200 m isobath (48°41.72'N 126°17.85'W). The western boundary follows the 200 m isobath. The eastern

boundary is the coast of Vancouver Island, except for a straight line between Amphitrite Point on the north side of Barkley Sound (48°55.23'N, 125°32.39'W) and Cape Beale on the south side (48°47.17'N, 125°13.04'W). This 'bounding box' includes 90% of encounters documented with SRKWs off the west coast of Vancouver Island and the majority of NRKW encounters. It includes the Canadian portions of Swiftsure Bank, where acoustic monitoring revealed considerable habitat use by both SRKW and NRKW over much of the year. It also includes several other relatively shallow banks including La Pérouse Bank to the northwest which, like Swiftsure Bank, are among the most productive fishing areas for Chinook and other salmonids on the North American west coast.

Western Dixon Entrance

Western Dixon Entrance is important habitat for NRKWs throughout the year, particularly in late winter and spring. NRKWs were detected acoustically on recording instruments deployed off the east side of Langara Island on an average of more than half of the days in each of March, April and May, 2009–2012. During these months, NRKWs are mostly absent from their summer core area and only designated critical habitat in Johnstone Strait off northeastern Vancouver Island. There is no other known area within the range of the population that is frequented as often, and as regularly, by NRKW groups as western Dixon Entrance.

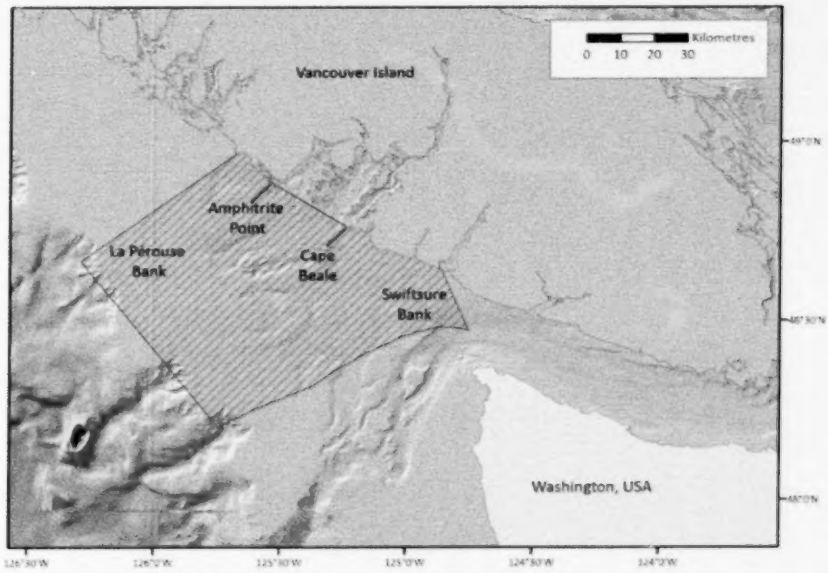
Pods, and the acoustic clans with which they are affiliated, occurred in significantly different proportions in western Dixon Entrance compared to the Johnstone Strait critical habitat area. Although all 16 NRKW pods were identified in each area, half of these pods were present in far greater proportions of encounters in western Dixon Entrance than in Johnstone Strait. These groups were also detected frequently on the Langara Island acoustic recorder. Certain pods that are rarely encountered in Johnstone Strait at any time of year were often encountered or detected acoustically in western Dixon Entrance. As habitat needed for recovery, western Dixon Entrance would appear to be far more relevant to these and several other NRKW pods than the Johnstone Strait area.

Western Dixon Entrance is an important feeding area for NRKWs, which target Chinook Salmon selectively. All but one of the 80 kills identified from NRKW predation in the area were of this species. Western Dixon Entrance has long been known as a highly productive commercial trolling ground for Chinook as well as a very important area for recreational Chinook fishing. The prolonged durations of acoustic encounters with NRKWs on the Langara Island recorder suggest that the animals regularly make use of the habitat, likely for foraging, rather than just transiting the area.

A 'bounding box' that encompasses areas of important habitat for NRKWs in western Dixon Entrance is shown in Figure 3B. It includes most coastal waters off the north side of Graham Island out to the 200 m isobath, except for shallow areas of Naden Harbour, Massett Inlet, and McIntyre Bay. The western boundary is delineated by a line extending from Meares Point on Graham Island (54°11.06'N, 133° 01.56'W) to Iphigenia Point on the south side of Langara Island (54°11.42N, 133°00.76'W) and a line extending from Langara Point on Langara Island (54°15.37'N, 133°03.49'W) to a point 1.8 km (1 nm) to the north (54°15.99'N, 133°03.49'W). The northern boundary of the area follows the 200 m isobath approximately 90 km to the east from this point to a position 13 km north of Rose Point on Graham Island (54°16.03'N, 131°40.43'W). A straight line from this position to Rose Point forms the eastern boundary of the proposed area. Excluded from this area are shallow waters of Virago Sound (south of a line from Jorey Point (54°45.57'N, 132°34.30'W) to Cape Edensaw (54°05.86'N, 132°26.25'W)) and McIntyre Bay (south of a line from Striae Island (54°05.48'N, 132°15.39'W) to Rose Point). The total area of this bounding box is 1394 km^2.

This potential critical habitat area includes the locations of 85% of encounters and 95% of predation events documented in western Dixon Entrance as well as most of the estimated zone of detectability of Killer Whale calls from the Langara Island acoustic recorder. It also includes the main area of the highly productive Chinook troll fishery to the east of Langara Island that has continued for many decades and is the location of a major recreational fishery focused on Chinook. This fishing ground extends roughly 20 km east of Langara Island, and the majority of NRKW predation has been observed there. Between this fishing ground and Rose Point at the eastern extent of the bounding box, predation on Chinook Salmon has been documented at a high rate relative to effort. Whales using this area typically arrive from the east having rounded Rose Point from Hecate Strait or eastern Dixon Entrance, and depart to the east when leaving the area. They have seldom been observed to travel or forage west of Langara Island, hence this area has not been included in proposed critical habitat. Naden Harbour and Masset Inlet, as well as the shallow inshore portion of McIntyre Bay, have been excluded as the whales do not use these areas extensively.

A. Southwestern Vancouver Island



B. Western Dixon Entrance

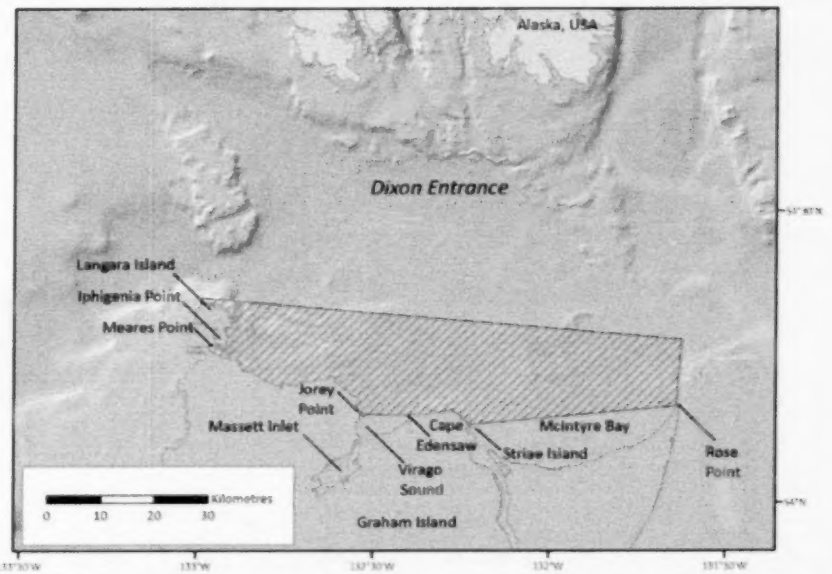


Figure 3. Bounding boxes enclosing habitats of special importance to SRKWs and NRKWs off southwestern Vancouver Island (A, top) and for NRKWs in western Dixon Entrance (B, bottom).

Biophysical Functions, Features and Attributes of Important Habitat Areas

As noted above, seasonal distribution and movement patterns of RKWs are strongly associated with the availability of their preferred prey, Chinook Salmon, and secondarily, Chum Salmon. Thus, habitats that are important for the survival and recovery of RKWs are those that provide for profitable foraging on these key prey species. Foraging occupies the greatest portion of the activity budget of Resident Killer Whales. Other activities, including resting and socializing, take place between foraging bouts and the locations of such activities are not determined by any particular feature of the whales' habitat. The only activity that is strictly associated with particular geographic locations is beach rubbing by NRKWs, which only takes place at specific traditional sites within previously identified critical habitat off northeastern Vancouver Island.

Areas of important habitat off southwestern Vancouver Island and in western Dixon Entrance are highly productive areas for Chinook and other salmonids, which is the most important feature that supports the function of feeding by Resident Killer Whales. Both areas are characterized by nutrient-rich waters resulting from strong tidal mixing and upwelling, which drives productivity of prey species favoured by Chinook Salmon – primarily Pacific Herring, Pacific Sand Lance, and euphausiids.

The functions, features and attributes of these potential critical habitat areas are summarized in Table 1.

Table 1. Functions, features and attributes of important habitat areas off southwestern Vancouver Island and in western Dixon Entrance.

Function	Feature	Attribute
Feeding and foraging	Sufficient quantity and quality of Chinook Salmon and other important prey species	Diversity of Chinook stocks with a variety of spatial and temporal migration patterns Other species that comprise part of the RKW diet
Feeding and foraging Reproduction, socializing, resting	Acoustic environment	Ambient noise levels that allow effective acoustic social signaling and echolocation to locate prey Noise levels that do not result in loss of habitat availability or function
Feeding and Foraging Reproduction, socializing, resting	Water column	Diversity of Chinook stocks with a variety of spatial and temporal migration patterns Other species that comprise part of the RKW diet Water and/or air quality of a sufficient level so as not to result in loss of function
Feeding and Foraging Reproduction, socializing, resting	Physical space	Unimpeded physical space surrounding individual whales (minimum 200 m for SW Vancouver Island)

Activities Likely to Destroy Habitat Functions, Features and Attributes

Examples of activities that would likely destroy critical habitat for RKWs are described in detail in the Recovery Strategy (Fisheries and Oceans Canada 2011). Most of these also apply to the areas of important habitat identified here, except for activities that would affect beaches used for rubbing by NRKWs. No rubbing beaches have been identified in either of the areas of special importance identified here. Activities likely to result in the destruction of the biophysical functions, features and attributes of important habitats identified here are summarized in Table 2.

Sources of Uncertainty

Most information on the diet of RKWs is based on sampling of predation events during summer and fall. It is assumed that Chinook Salmon remains the primary focus of foraging efforts by RKWs throughout the year, but other prey species (e.g., Sablefish, Pacific Halibut) may be important during winter in the habitats identified here.

Many aspects of the functions, features and attributes of both legally identified critical habitats and the habitats identified here are inadequately understood and require further study. For example, Resident Killer Whales likely require a minimum density of Chinook Salmon in critical habitat areas in order to forage profitably, which is why they concentrate in particular Chinook 'hot spots' at certain times of year. However, the minimum density, quantity and quality of Chinook and other important prey species required are unknown. Studies to estimate such a threshold are needed for any assessment of the extent of prey reduction that might result in the loss of the feeding and foraging function of Resident Killer Whale critical habitat. Similarly, the types and levels of underwater sound that cause short-term and long-term effects on Resident Killer Whales are poorly known. There has been considerable recent research on the noise levels in Resident Killer Whale habitats and responses of the animals to such noise, but thresholds that might result in critical habitat destruction are still unclear.

CONCLUSIONS AND ADVICE

The habitat areas identified in this report are of sufficient importance to Resident Killer Whales that they warrant consideration as additional critical habitat for these populations. The southwestern Vancouver Island area is important habitat for both SRKW and NRKW throughout the year. The western Dixon Entrance area is similarly important for NRKWs in most months of the year, particularly in winter and spring. The functions, features and attributes have been described, and activities likely to destroy the habitats' functions include vessel traffic causing acoustic masking or disturbance, acute noise sources (e.g., pile driving, seismic testing) and release of deleterious substances (e.g., oil spills).

It is unclear if the habitats described here, in addition to legally identified critical habitats, are sufficient to fully meet the objectives of the Recovery Strategy for Resident Killer Whales. Additional areas of potential critical habitat likely exist and should be assessed for their importance to the survival or recovery of these populations.

Table 2. Activities that are likely to result in destruction of the biophysical functions, features and attributes of important habitats.

Threat	Activity	Effect Pathway	Function Affected	Feature Affected	Attribute Affected
Reduced prey availability	Over fishing of prey species Other activities that are detrimental to habitat of prey	Loss of prey Loss of forage fish for prey species	Feeding and foraging	Sufficient prey density, quantity and quality	Diversity of Chinook stocks with a variety of spatial and temporal migration patterns Other species that comprise part of the RKW diet
Acoustic disturbance	Vessel traffic Seismic surveys, military and commercial sonars Pile driving, underwater explosions	Chronic noise resulting in masking of communication and echolocation Acoustic disturbance resulting in loss of habitat availability or function	Feeding and Foraging Reproduction, socializing, resting	Acoustic environment	Ambient noise levels that allow effective acoustic social signaling and echolocation to locate prey Noise levels that do not result in loss of habitat availability or function
Environmental contaminants	Deposit of deleterious substances into marine environment	Loss of prey or reduction in prey quality Loss of water and/or air quality	Feeding and foraging Reproduction, socializing and resting	Sufficient prey quantity and quality Water column Boundary air layer over ocean surface	Diversity of Chinook stocks with a variety of spatial and temporal migration patterns Other species that comprise part of the RKW diet Water and/or air quality of a sufficient level so as not to result in loss of function
Physical disturbance	Vessel traffic in close proximity to whales	Reduction of physical space available to whales	Feeding and Foraging Reproduction, socializing, resting	Physical space	Unimpeded physical space surrounding individual whales (minimum 200 m for SW Vancouver Island)

SOURCES OF INFORMATION

This Science Advisory Report is from the February 23-26, 2016 "National Marine Mammal Peer Review Committee (NMMPRC): Part II", under Topic 1: Habitat Requirements for Killer Whale (Northeast Pacific northern and southern resident populations), Fin Whale (Pacific), and Blue Whale (Atlantic). Additional publications from this meeting will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Fisheries and Oceans Canada. 2011. Recovery Strategy for the Northern and Southern Resident Killer Whales (*Orcinus orca*) in Canada. Species at Risk Act Recovery Strategy Series, Fisheries & Oceans Canada, Ottawa, ON. ix + 80 p.

Fisheries and Oceans Canada. 2016. Action Plan for the Northern and Southern Resident Killer Whale (*Orcinus orca*) in Canada. *Species at Risk Act* Action Plan Series. Fisheries and Oceans Canada, Ottawa. iii + 32 pp.

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